White Paper

Allocation of G and H Blocks of the PCS Band

Interference Analysis
And
Interference Mitigation
Analysis

Intermodulation Interference in Mobile PCS Receivers

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Executive Summary

The FCC Docket 00-258 is concerned with the allocation of the H block of the PCS band for CMRS services. As always, a change in spectrum allocation and usage will have an impact on existing services. This paper deals with the interference associated with the allocation of the G and H blocks in the PCS band, primarily 3rd order intermodulation products (IMD).

In this paper we will show that the addition of the H block to the PCS band will have a noticeable impact on already existing services due primarily to the addition of new 3rd order intermodulation products. The simple existence of new signals will create new intermodulation products, but worse, the reduction of the guard band imposes a severe constraint on the filtering requirement beyond that which existing technologies are able to handle. IMDs will be caused by G and H blocks and G and H blocks will be impacted by IMDs from MSS/ATC.

The primary effect of the 3rd order distortion products is to increase the apparent noise floor in the handset. Less obvious, but equally true, is that this impacts the capacity and effective coverage of the network resulting in more dropped calls and requiring more base stations to handle the traffic load. As cell phone usage increases the problem will only get worse.

There are other potential issues involved with the addition of new services, such as the potential compression of the LNA. In this paper, we will show that the other potential problems are relatively minor in comparison with the addition of new 3rd order distortion products.

While 3rd order distortion products have the potential to have a serious impact on the network capacity, there are several technologies that promise to help substantially. In addition to new filtering techniques such as the use of FBAR filters, there is an advanced active interference cancellation technology, which in combination with filtration can mitigate or remove most or all observable IMD. The Finesse Wireless IMD cancellation techniques is one such approach which has already been shown to increase capacity, and has the potential to solve the problem altogether. This paper explores its implementation and the effects it has in simplifying the harmonious and effective deployment of communications services in the G and H bands.

1. Introduction

The FCC has recently taken steps to allocate the G Block of the PCS band to mitigate interference to the public safety radios in the 800 MHz band The reason for this allocation was to remove the interference to the public safety radio systems. Cellular basestation transmitter signals have been mixing with other service provider basestation signals and producing 3rd order Intermodulation Products (IMD). These IMDs have been jamming public safety radios in numerous cities around the United States.

The FCC is planning to open up the H Block for CMRS use as well. This will result in the reduction of the transmit to receive guard band for PCS mobile terminals and basestations from 20 to 10 MHz. It will also result in the guard band between the PCS mobile receive to the mobile transmit MSS/ATC being reduced from 10 MHz to zero. This has created considerable concern in many parts of the wireless industry for several reasons. The primary concern has been the potential interference to existing license holders in the PCS band and the MSS/ATC due to out of band emissions. The residual energy in the G and H bands after filtering could potentially cause the LNA in other mobile units to be driven into saturation causing compression distortion. This has been the main focus of concerns to date.

As will be shown in this paper, the energy in the G and H bands will have a low probability of causing compression in the LNA, however, the residual signals mixing with specified blockers in the PCS passband for CDMA2000, WCDMA, GSM, GPRS and EDGE will have a high probability of resulting in very damaging 3rd order IMDS. ***These are the same mechanics that caused the interference originally in the public safety radios.***

Finesse Wireless Inc. has patents pending on a new IMD cancellation technology that will mitigate the IMD limitation from the allocation of the G and H blocks. The analysis contained herein looks at the compression issues and the IMDs which can severely reduce the mobile terminal receiver sensitivity. It will also show MATLAB simulation results and the benefit of the Finesse Wireless IMD cancellation technology which can reduce IMD interference by 20dB +. The IMDs can be any modulation or bandwidth and will be suppressed in real time. Multiple IMDs can be suppressed simultaneously and no energy is removed from the signal of interest. This is not a notch filter technology. This technology will be deployed in the mobile receivers and the details of how this is done can be disclosed to interested parties under an appropriate NDA.

The combination of appropriate out-of-band emissions limits in the FCC's service rules, improved filter/duplexer performance and IMD cancellation technology makes both G and H band viable for CMRS use. Without this combination, the introduction of G and H band threatens to create significant interference affecting both existing license holders (PCS and MSS/ATC) as well as new G and H licensees.

2. Reference Documents

Ref 1: Nextel ET Document: ET Docket No. 00-258; Ex Parte Presentation; August 5, 2004 Addressed to Ms. Marlene H. Dortch, Secretary Federal Communications Commission

Ref 2: Effect of Duplexer Performance on H Block Use for US PCS; Agilent Technologies Presentation; William Muller, Wireless Semiconductor Division; August 3, 2004. (An addendum to Ex Parte reference 1.)

Ref 3: Motorola: WT Docket No. 00-258; IB Docket NO. 99-81; Ex Parte Presentation; July 16, 2004 Addressed to Ms. Marlene H. Dortch, Secretary Federal Communications Commission

3. Spectrum and Potential Interference Scenarios; LNA Compression and IMDs

The present spectrum situation is shown in Figure 1 (from reference 3). This creates three potential interference scenarios. For each scenario, the potential strength of the residual unwanted signals, after free space attenuation and filtering, will be analyzed and then the potential for compression distortion and IMD interference in the target receiver will be evaluated.

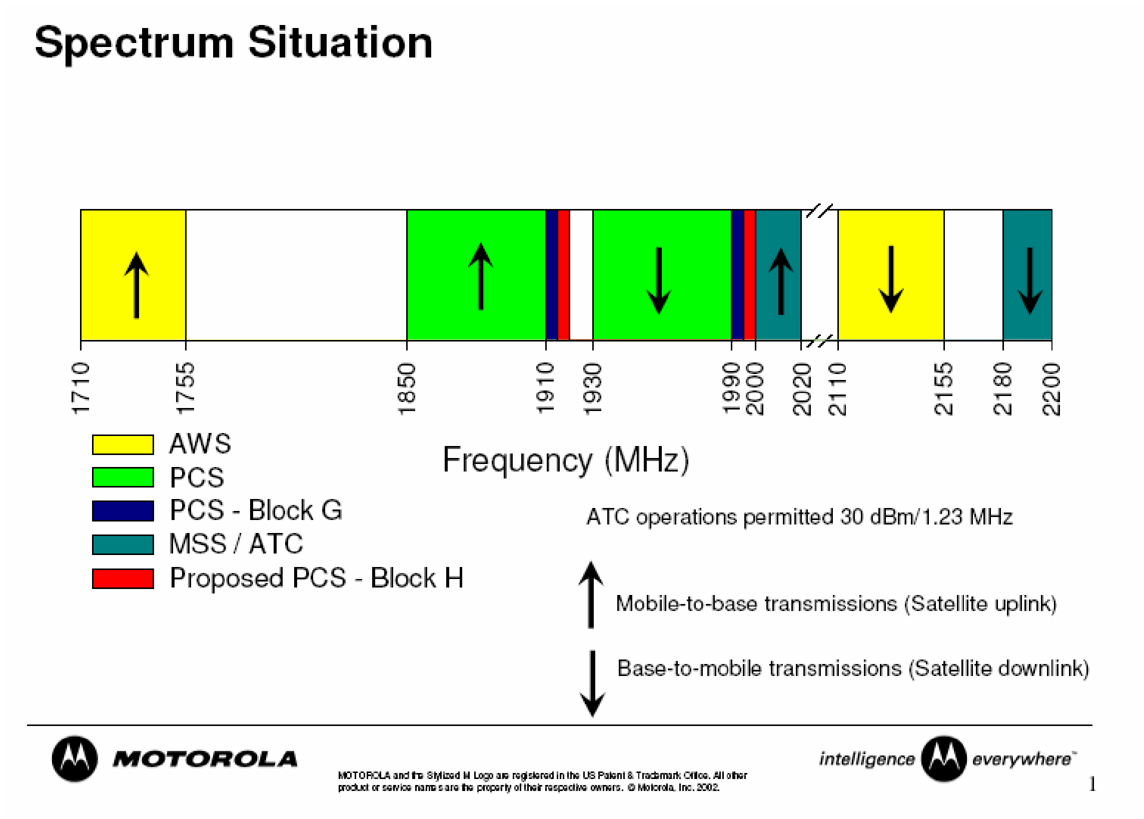

Figure 1 Spectrum Situation

3.1 <u>Scenario 1</u>: G and H block Transmitter Interference to PCS Blocks A-F

3.1.1 G and H Residual Power and Potential LNA Compression Distortion

3.1.1.1 CMDA2000 – Full Duplex; Receiver with the FBAR Duplexer

Assuming a maximum transmit power from a mobile of +30 dBm and body absorption loss of 4 dB and a free space loss at 1 meter of 32 dB, the signal strength at the antenna of a PCS mobile terminal will be -6dBm. From Agilent data (reference 2), page 13 Rx Consideration 1, part 2, rejection of G block energy is 40dB and rejection of H block is 15 dB. The residual power in G block is -46dBm and residual power in H block is

-21dBm. The G block can be supported by the existing FBAR technology with regard to compression, but IMDs pose a possible problem.

The blocker specification for GSM is -26dBm and -21dBm for CDMA2000. That makes the residual signal strength in the G and H blocks near the specified blocker signal strengths. Typical advertised LNA IIP3 values for GSM and CDMA are +10 to +12dBm. (Reference Maxim high gain and high linearity models MAX2323 and MAX2325.) If the signal in the passband as seen by the LNA is at least 20dB below the IIP3, linear operation can be assumed and the LNA will not cause compression distortion. Compression in the LNA should not be realized for signal strength below -8 to -10 dBm. After channel selection in the PCS receivers, the residual G and H band blocker energy should not be a problem. The residual energy can however cause IMD interference as discussed below, prior to final channel selection.

3.1.1.2 GSM – Half Duplex; Receiver with a SAW Filter; No FBAR Duplexer

GSM mobiles are half duplex and do not require the high mobile transmit to receive band isolation. The common architecture uses a transmit/receive switch and a SAW filter in place of the FBAR duplexer. Figure 2 shows the rejection for the TriQuint SAW filter for the PCS band. Rejection at mid H block is around 8dB and about 20 dB for G Block. This results in residual energy of -26dBm and -14dBm for G and H blocks respectively. Given an LNA IIP3 of +10 to 12 dBm, the total power is still 20 to 25dB below the IIP3 point and compression should not be an issue, but IMDs can be.

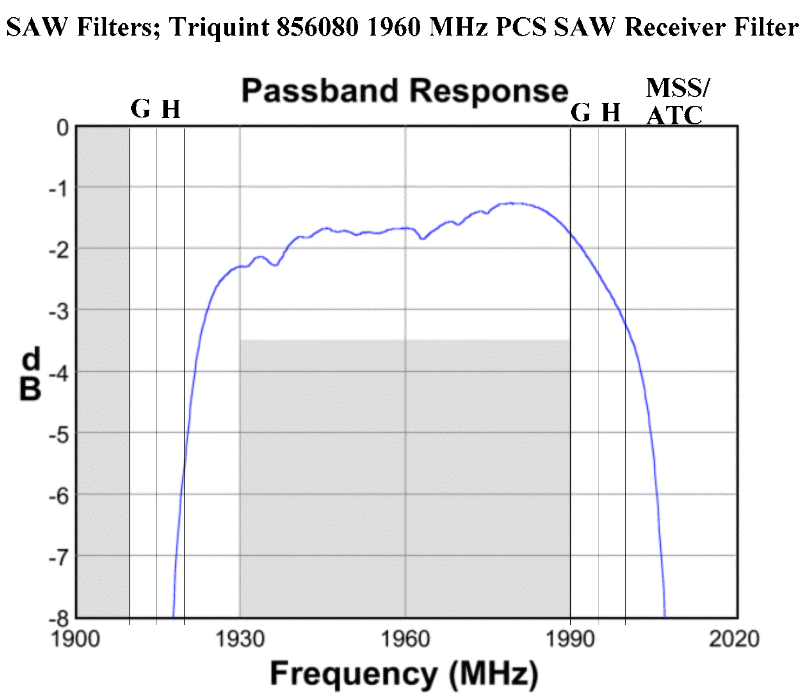

Figure 2: PCS SAW Filter Passband and Out of Band Signal Rejection

3.1.2 Intermodulation Products from G and H block Signals and Specified Blockers for CDMA2000, GSM, GPRS, EDGE and WCDMA

The LNAs in the PCS mobile receivers are very broadband devices and must rely on filtering prior to the LNA input to reject unwanted signals that can cause interference. The power in a 3rd order IMD can be predicted by the following equation:

$$IMD(dBm) = P_1(dBm) + 2x\ P_2(dBm) - 2xIIP3(dBm)$$

Where:

IMD(dBm): is the power in the 3rd order intermod in dBm
P_1(dBm): is the power in the blocking signal used once to create the IMD in dBm
P_2(dBm): is the power in the blocking signal used twice to create the IMD in dBm
IIP3(dBm): is the input 3rd order intercept point

Given that the G and H block signal would be at one end of the PCS band, these are the signals that would be represented by P_1.

Given residual power in the G band of -26dBm for the SAW filter case, and a -26dBm blocker in the passband with a very good GSM direct conversion receiver, and a cascaded IIP3 of +3 dBm; the IMD would be at -84dBm. With the FBAR, the power in the G block would be -46dBm and this could result in an IMD at -46-52-6 = -104dBm. The H block signal at -14dBm mixing with a blocker at -26dBm would result in an IMD of -72dBm for the SAW filter case and -79dBm for the FBAR case (H block signal at -21dBm). Blockers at -25 to -30 dBm are not uncommon. As can be seen, with the specified values of blocking signals for the mobile telephony standards, IMDs produced by mixing products from the G and H blocks can be severe. As will be shown below, the Finesse Wireless technology can recover 20 dB+ of receiver sensitivity lost to IMDs and make both the G and H block allocations viable.

Table 1 shows the potential IMDs with a -26dBm blocking signal mixing with the residual energy in the G and H bands for a PCS receiver with good linearity. CDMA uses FBAR and GSM uses a SAW Filter. These are typical values and a full range of values are analyzed below. With the exception of CDMA with G band interference, the IMD power levels for the other three scenarios are all well above the receiver noise floors, which is cause for concern.

PCS Receivers	Standard	G band	H band
GSM (SAW filter)	Sensitivity -108dBm	-84 dBm IMD	-72 dBm IMD
CDMA (FBAR duplexer)	Ioc -105dBm	-104 dBm IMD	-79 dBm IMD

Table 1

With Nominal Values for Mobile Transmit Power Levels, Filtering, and PCS Receiver IIP3, the IMD Power Levels Caused by G and H block Residual Energy Mixing with Inband Blockers Can be Significant

3.2 Scenario 2: MSS/ACT Mobile Transmitter Interference into G and H band Mobile Receivers

The MSS/ATC mobile transmit power will be a maximum of +30dBm. Given the roll off of characteristics of the SAW filter in figure 2, we can assume that the residual power seen by the G and H bands will be on the order of 30dBm – 32dBm -5dB = -7dBm at 1 meter separation and -13dBm at 2 meters and -19dBm at 4 meters. These are well within the reasonable distances for two persons using cell phones. Compression issues become marginal at 1 meter and not a problem at 2 meters and greater given an LNA with an IIP3 of +10 to +12dBm. Note that more narrow SAW filters with better roll off may be viable as with the FBAR. There is an inverse relationship between the passband width and the roll off. This however precludes continuous use of the entire PCS band blocks A-H without additional filter elements.

3.3 Scenario 3: G and H Block Basestation Transmitter Signal Interference to MSS/ATC Basestations

The G and H block basestation transmitters will have transmit power levels on the order of 38 to 44 dBm (Note: typical basestation outputs are 41-44 dBm, minus cable losses of ~ 3 dB) with EIRPs up to 60 dBm and can create blockers in the -20 to-25 dBm range fairly readily at the antenna of the MSS/ATC basestation. If we assume the MSS/ATC out of band reject similar to what we get with the SAW filters shown in figure 2, then the residual power in the G and H band can be on the order of -30dBm. If we have a cascaded IIP3 of +3 dBm, the IMDs can be at -96dBm or higher. Compression is not likely to be a problem as discussed above, but depending on the linearity of the receiver, IMDs can be a problem.

4.0 IMD Cancellation Technology MATLAB Simulation Results

4.1 The Intermodulation Interference Problem (PCS Band)

Intermodulation products (IMD) are produced in the nonlinear elements of the handset receiver and directly impact the sensitivity of the receiver. As shown in Figure 3 for the PCS band of North America, high power base stations of other service providers transmit high power signals in the same 60 MHz receive band, which the cell phone must accommodate at the receiver RF front end. These transmitters are nominally on the order of 38 to 44 dBm, with EIRPs as high as 50 to 60 dBm. The location of the other service providers within the 60 MHz channel does not impact the magnitude of the 3rd order IMD as long as the relative frequency spacing will result in an IMD inband of the signal of interest (SOI). As shown in figure 3, if X = Y, then the 3rd order IMD will fall inband. The source signals for the 3rd order IMDs can be close in to the SOI or anywhere in the allocated receive band. The specifications for CDMA2000 require a two tone test with the tones at -21dBm with a SOI sensitivity of -94dBm. When the tones are absent, the SOI sensitivity requirement is -119dBm. The CDMA system gives up 25dB in sensitivity when the high power tones (typically AMPS signals) are present.

The source signals which generate the 3rd order IMDs may not be AMPS signals, but can be wider band signals such WCDMA, GSM, EDGE and or TDMA IS-136 or similar air interface standards. If there are companion signals with the appropriate frequency spacing and power levels, the power in the inband IMD will be the same as for AMPS. The power in the IMD will be:

$$IMD(dBm) = P_1(dBm) + 2xP_2(dBm)- 2*IIP3(dBm)$$

where P_1 (dBm) is the power in the first source signal and P_2 (dBm) is the power in the second source signal and IIP3 is the system IIP3 of the handset (the cascaded IIP3 of all components).

If the source signals produce a wideband IMD, then only that portion of the energy that falls inband of the signal of interest will interfere with the SOI. For this paper, the source signals will be assumed to be tones to simplify the concepts presented, but as can be shown, the inband energy is the same. The Finesse Technology works for any bandwidth IMD, even if it is wider than the SOI.

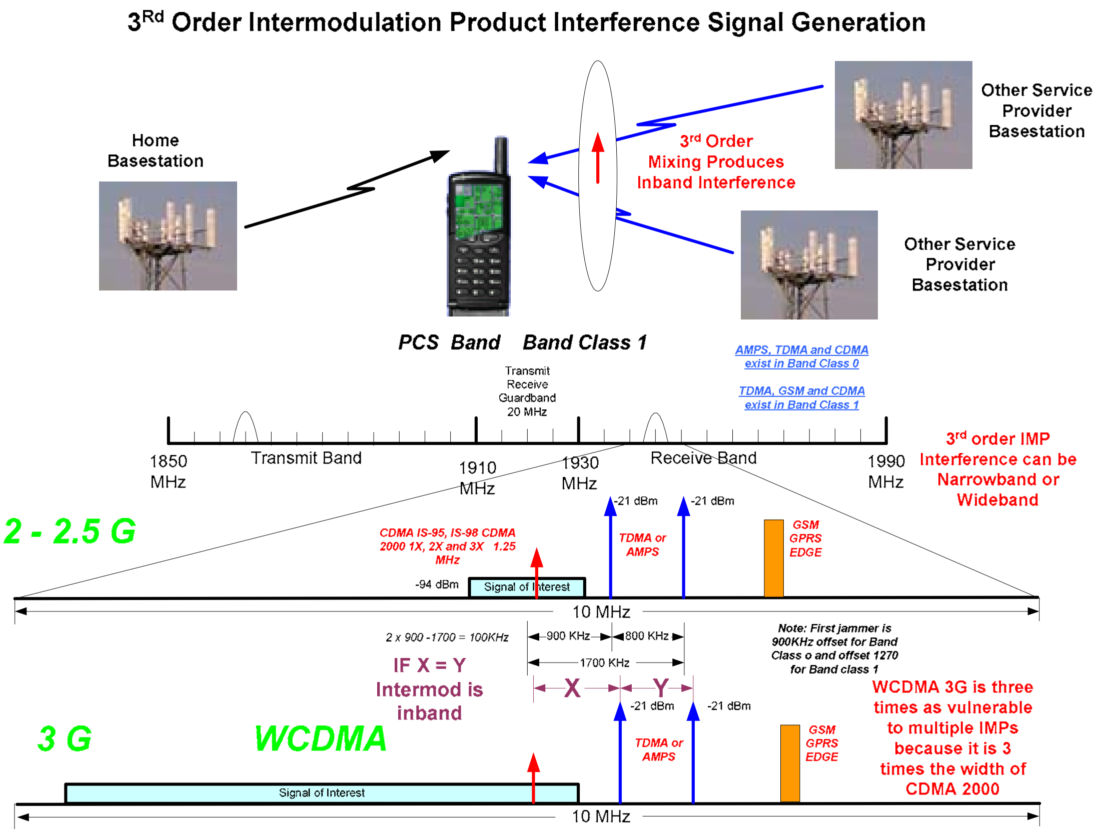

Figure 3.PCS Cellular Telephony Interference Environment

GSM and 3G WCDMA: The interference requirements for GSM and WCDMA are shown in figure 4. The two tone, 3rd order IMD, tests for GSM and WCDMA only require the systems to be designed for tones up to -49dBm, and do not account for the very close in blocker at -43dBm. As can be seen in figure 4, there are specified blockers as high as -26dBm specified within the 60 MHz PCS receive band for North America. In reality, as shown in Figure 3, WCDMA will be exposed to the same high power interfering signals as specified for CDMA2000.

The GSM and WCDMA specifications assume that the handset will be on the order of at least 200 meters from the offending base stations. As can clearly be demonstrated by driving down most elevated freeways in North America, this is not always the case and multiple transmitters are often less than 20 to 30 meters off the roadway. There are often numerous service providers on the same tower and multiple towers close together. This is to be expected, because if the location is good for one provider, it is good for most others. Real estate for placing cellular base stations is at a premium. If the free space loss calculations are run, the 200 meters explains the difference between the CDMA2000 two tone specification of -21dBm and that of GSM and WCDMA at -49dBm. In reality, all signals will experience the same level of interference. While the impact of 3rd order interfering signals on GSM is not covered in the simulations contained herein, it is interesting to note if a GSM handset has a system IIP3 of +5dBm (probably optimistic) and the tones are at -21dBm, the inband 3rd order IMD will be at -71dBm, or 35dB above the GSM sensitivity requirement for GSM voice. At the specified level of -49dBm, the IMD generates no significant interference. Field measurements readily show blocking signals are common at -30 to -35dBm. Signal levels between -30 dBm and -21dBm are seen, but not as often. As the density of basestations increases, the down-tilt angle of the antennas is increased and the potential interference becomes greater, as has been seen with Nextel and the public safety radios.

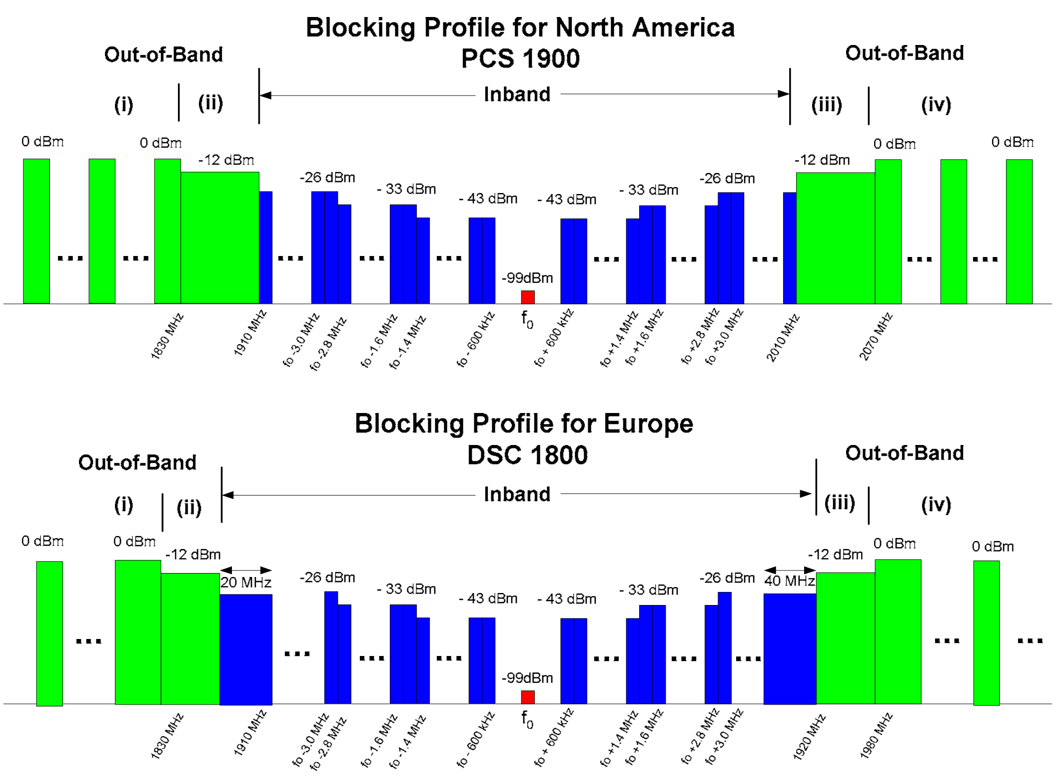

Figure 4 Blocking Requirements for GSM and 3G WCDMA

4.2 IMD Interference Mitigation Technology, System Simulations

A MATLAB system simulation was built for a CDMA2000 receiver with performance specifications that just met the high power two tone test. Figure 5 shows the SOI and the IMD generated by the system that meets the sensitivity requirement of -94dBm in the presence of source signals at -21dBm. Figure 6 shows the improvement when the IMD is cancelled by the Finesse Technology. In the simulations, the SOI is shown as a tone so the relative strength can be seen. In fact, it is below the noise floor and spread by 21 dB. In the real world the source signals, that generate the IMDs, are not tones but are modulated signals. An additional simulation was run with simulated FM AMPS signal with a 30 kHz bandwidth. Figure 7 shows the SOI plus the IMD prior to IMD suppression. Figure 8 shows the SOI after IMD suppression. As shown in Figure 8, there is a small residual of the modulated IMD. This can be eliminated when the differential group delay is taken into account. Even at the present level, when the IMD is spread by the CDMA2000 spreading gain of 21dB, it will have no impact on the signal to interference ratio.

The simulations are predicting 20 dB plus of suppression for the modulated and tone IMDs respectively. As will be shown below, significant sensitivity and system capacity improvements can be achieved with IMD suppression in the mobile handset.

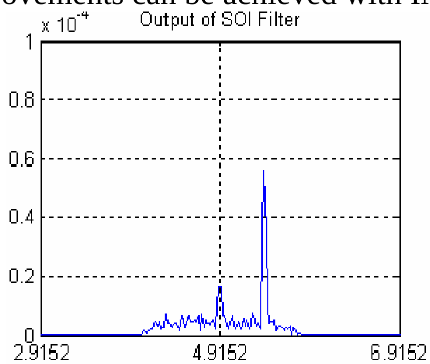

Fig. 5: SOI Plus IMD from High Power Two Tone Test

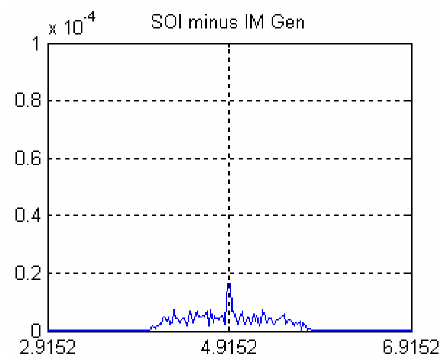

Fig. 6: SOI After IMD Suppression of IMD
from High Power Two Tone Test

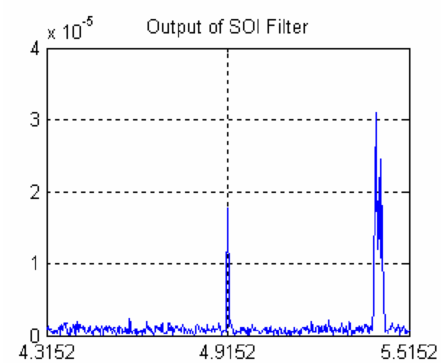

Fig. 7: SOI Plus AMPS IMD from High Power Two Tone Signal Test

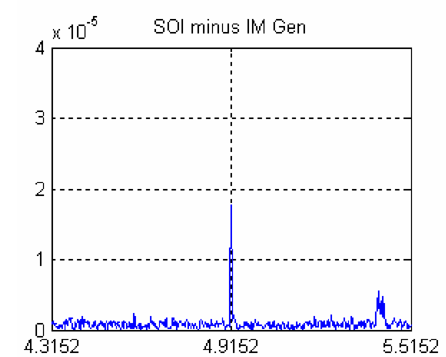

Fig. 8: SOI After IMD Suppression of IMD from High Power Two Tone Test

5.0 IMD Interference Impact to CMDA2000 and GSM Receivers and IMD Interference Mitigation for PCS G and H Block Interference

Given that the power levels and interference levels can vary greatly as discussed above, an analysis has been conducted assuming some "reasonable" values. It is possible that pathological and very optimistic numbers that will fall outside the range of this analysis. The impact to cellular voice and data systems can be severe and IMD suppression can recover a high percentage of the system sensitivity and capacity. Two white papers are available at http://www.finessewireless.com for those who wish to review a detailed analysis of the topic for CDMA systems and TDMA systems for the existing PCS band without the G and H block issues discussed herein.

One of these papers addresses CDMA2000 and WCDMA and the second addresses GPRS/EDGE. The IMDs on the order of those described here can reduce systems capacity by up to 90%. The IMD cancellation can recover up to 90% of the loss.

5.1 Parameters for IMD Analysis for G and H Blocks:

5.1.1 Receiver Linearity:

Given a high quality receiver with an LNA with an IIP3 of +12 dBm, a cascaded IIP3 through the entire receiver chain up to the A/D converters could be 0dBm to +5 dBm. Direct conversion receivers which are the de facto standard would not have an IF SAW and would have to deal with the non-linearity through entire receiver chain. If the receiver chain has a lower cascaded IIP3, the IMD impact will be greater.

5.1.2 Noise Figure

The noise figure is not a critical value in this analysis, however, it sets the system noise floor. The IMD cancellation provides a dB for dB of improvement in receiver sensitivity down to the noise floor of the receiver. For this analysis, a NF of 7 dB is assumed.

5.1.3 G and H block Mobile Transmitter Power Level

While the maximum output power could be as high as +30 dBm, 28 dBm is more common and we will assume a 4 dB body loss for a resultant EIRP of 24 dBm. The analysis was conducted for transmit power levels from 24 to 0 dBm.

5.1.4 Free Space Loss

The free space for 1 and 2 meter spacing for mobiles was 32 dB and 38 dB respectively.

5.1.5 Receiver Sensitivity in an Interference Free Environment and SNR

The sensitivity for the CDMA2000 receiver was –119 dBm with a required SNR of 6 dB after de-spreading, and –108 dBm for GSM with a required SNR of 6 dB was used.

5.1.6 Blocker Signals in the PCS Band

GSM specifies a blocker signal at -26dBm (see Figure 4 above) and CDMA assumes a high powered signal at -21dBm. This analysis assumed the H block signal mixes with a blocker at -25dBm for CDMA and -26dBm for GSM.

5.2 GSM and CDMA2000 IMD Interference Impact and Mitigation

GSM and CDMA2000 are impacted differently by IMDs. In the analysis performed, the cascaded IIP3 for the GSM and CDMA receivers was 0 dBm and +5 dBm. The results shown here are for the H block transmitter with a CMDA2000 receiver being impacted and a GSM receiver being impacted by G and H block signals. The CDMA receiver sees a 15 dB attenuation of H block signals, but the GSM only sees an 8 dB attenuation due to the use of a SAW filter rather than an FBAR duplexer. In the G block, FBAR gives 40dB suppression of signals and the SAW Filter only yields 20 dB of suppression for GSM.

The analysis assumed 1 and 2 meter separation of handsets. In this model, it is assumed that the G and H band signal mix with a single blocker in the PCS passband. GSM specifies blockers at -26dBm. Given these signals, the expected 3rd order IMD for a very good receiver was computed. The results below show the receiver sensitivities for no IMD suppression and for 20 dB IMD suppression, as can be achieved with the Finesse Technology.

5.2.1 CDMA2000: FBAR duplexer; 15 dB Suppression of H Block Signals. Receiver Specified Sensitivity = -119.6 dBm

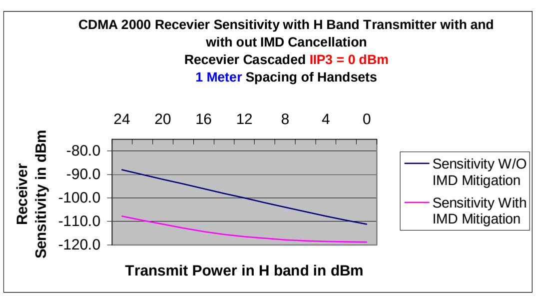

Figure 9 A

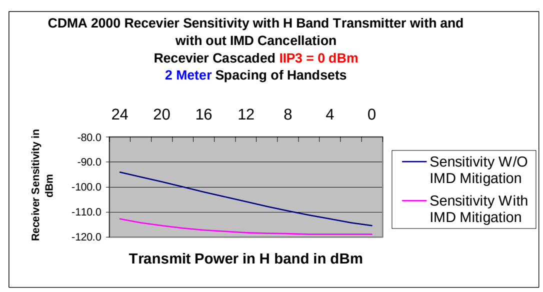

Figure 9 B

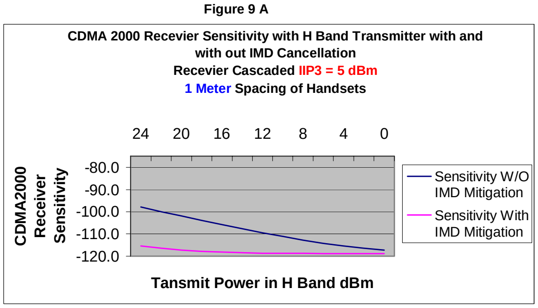

Figure 9 C

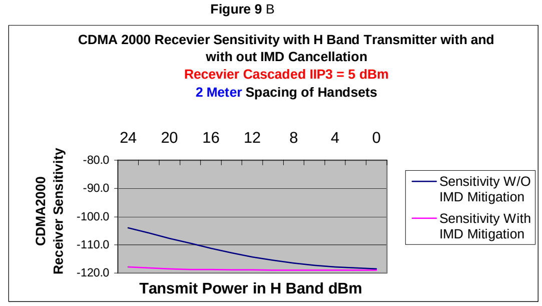

Figure 9 D

Figure 9: CDMA2000 PCS Receiver Sensitivity with and without IMD Interference Mitigation H Block Transmitter with PCS Mobile Receiver

As shown in Figures 9A thru 9D, the sensitivity of CDMA2000 mobile receivers in the PCS band suffer significant degradation in the presence of H band transmitter signals mixing with anticipated blockings signals in the PCS band. With the IMD cancellation, a significant amount of the receiver sensitivity is recovered.

5.2.2 CDMA2000: Assumes FBAR Duplexer; Yields 40 dB Suppression of the G Block Signals

The FBAR attenuates the G block signals by 40 dB and thus the IMDs from the G block mixing are not significant. Receivers with the FBAR duplexers are not impacted by signals in the G block. As will be shown, this is not true for GSM receivers that use SAW filter versus a duplexer because they are not full duplex.

5.2.3. GSM: Assumes a SAW filter, not a duplexer and this gives 8 dB suppression of the H band at best. Receiver Sensitivity Industry Standard -108dBm

As shown in Figure 10, the GSM mobile receivers in the PCS band can be significantly degraded by IMDs created by the mixing of the H block signals with blockings signals at specified levels. IMD cancellation technology recovers around 20 dB of receiver sensitivity under these conditions.

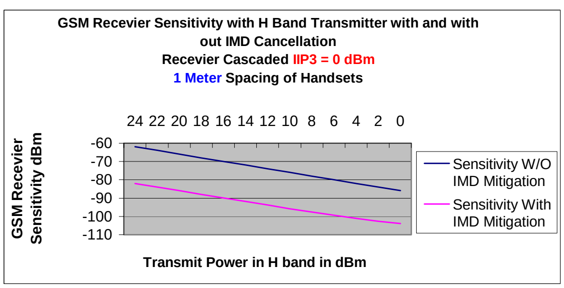

Figure 10 A

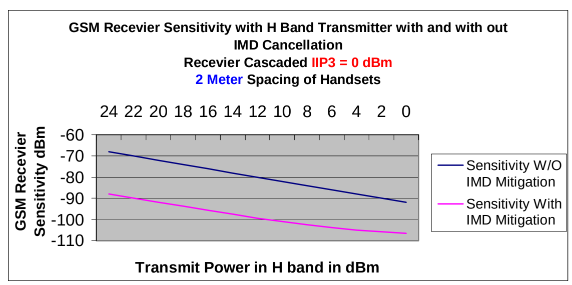

Figure 10 B

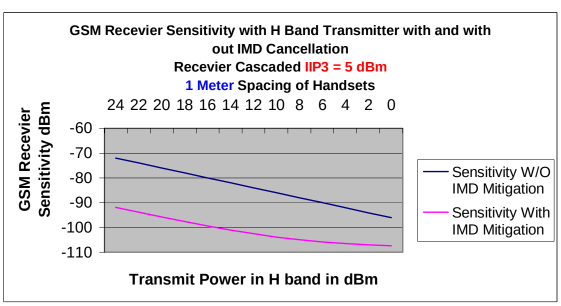

Figure 10 A

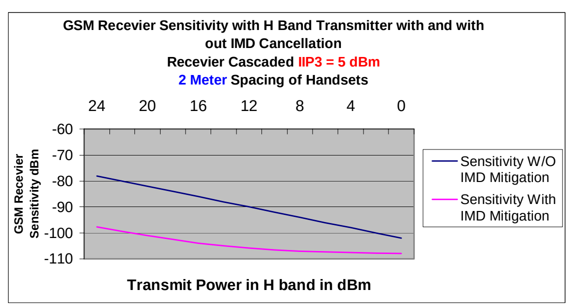

Figure 10 D

Figure 10: GSM PCS Receiver Sensitivity with and without IMD Interference Mitigation H Block Transmitter with PCS Mobile Receiver

5.2.4 G Block can Impact GSM Receiver - SAW Filter Architecture. Receiver Sensitivity Industry Standard -108dBm

PCS GSM mobile receivers are not full duplex and thus do not need the duplex isolation and use a SAW filter which normally would provide adequate out of band emissions as shown in

Figure 2. With the allocation of G and H blocks, the residual energy in the receive band is now significant. Mobile to mobile interference via the generation of IMDs is now a potential problem for GSM from both G and H blocks as shown in Figures 10 and 11. The IMD cancellation technology significantly mitigates this interference as shown in Figures 10 and 11.

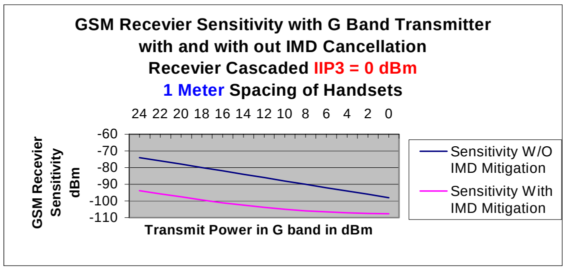

Figure 11 A

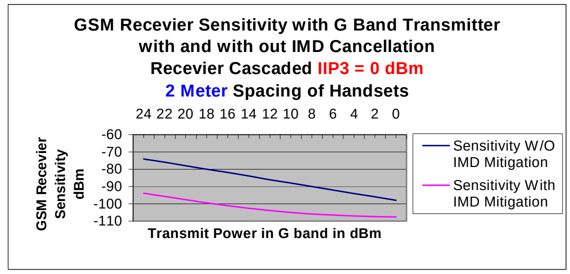

Figure 11 B

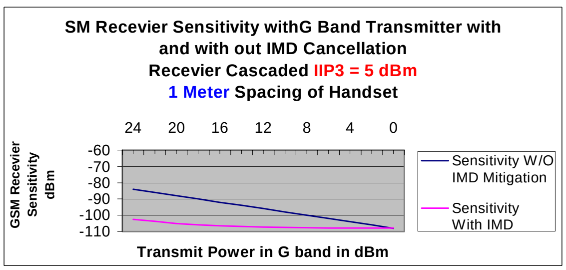

Figure 11C

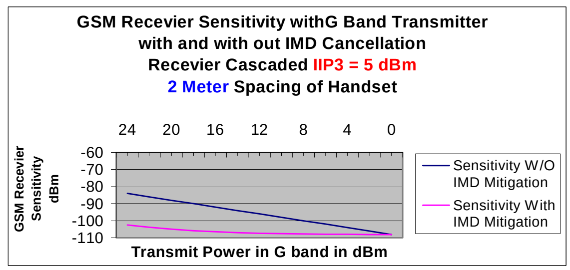

Figure 11 D

Figure 11: GSM PCS Receiver Sensitivity with and without IMD Interference Mitigation G Block Transmitter with PCS Mobile Receiver

6.0 Conclusions:

As can be seen above, the impact to CDMA phones with the FBAR is problematic and the impact to GSM phones is severe. If two basestations are co-located and the mobile units are at the edge of the cell, the "far-far" scenario is encountered wherein the mobile transmit power is at a maximum and the receive signal strength is at a minimum. The graphs above were computed for a separation of 1 and 2 meters. For each doubling of the distance between mobiles, the signal strength of the G and H signal is decreased by 6 dB and the IMD is decreased by 6 dB. (The G and H signals are a single contribution to the IMD with the inband PCS blocking signal being multiplied twice.) For GSM phones, the sensitivity of the phone will be impacted up to a separation of up to 32 meters or 100 feet.

6.1 The allocation of the G and H blocks of the PCS band will have a low probability of causing LNA compression due to the high linearity of the available LNAs, on the order of +10 to +12 dBm.

6.2 In the mobile to mobile scenario, the residual energy in the H block after filtering with the duplexer has sufficient energy that if a nominal specified blocking signal is present, significant degradation to CMDA2000 mobile receivers is possible via the creation of IMDs.

6.3 In the mobile to mobile scenario, the residual energy in the G and H blocks after filtering by a GSM SAW filter may have sufficient energy that if a nominal specified blocking signal is present, very significant degradation to GSM mobile receivers is possible via the creation of IMDs.

6.4 In the MSS/ATC to G and H mobile receive scenario, the residual energy in the MSS/ATC after filtering by a PCS SAW filter may have sufficient energy that if a nominal specified blocking signal is present, significant degradation to mobile receivers is possible via the creation of IMDs.

6.5 In the G and H basestation transmission interference to the MSS/ATC basestation scenario, the residual energy in the G and H blocks after filtering by a MSS/ATC SAW filter may have sufficient energy that if a nominal specified blocking signal is present significant degradation to MSS/ATC basestation receivers is possible via the creation of IMDs.

6.6 The Finesse Wireless IMD cancellation technology can recover up to 20 dB of the receiver sensitivity loss discussed above in 6.1 through 6.5. As is shown in the two papers referenced on the Finesse Wireless Inc. Web site; http://www.finessewireless.com, IMDs on the order of those described herein can result in loss of up to 90% of the capacity in CDMA, WCDMA, GSM, GPRS and EDGE Systems and IMD cancellation can often recover from 90 to 100% of the lost capacity. The improvement in receiver sensitivity can be translated into greater coverage range, deeper in-building penetration, greater interference immunity and or greater system capacity.

6.7 ***The combination of improved filtering/duplexing technology, appropriate out-of-band emissions limits and IMD interference cancellation technology makes both G and H bands viable for use in CMRS. This achieves the FCC's and the wireless industry's goals of making additional spectrum available in the marketplace***.

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